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(54) Title: CHEMICAL WARFARE PROOF TENT SHOT FABRIC

(57) Abstract: A tentage material suitable for military use (war or terrorism), offering chemical resistance and/or biological attack protection against penetration by toxic chemical. This tentage material is comprised of a polyester textile having a film laminated to it, an inner coating on each side and an outer coating on each side. The material is weldable, and can withstand the highly adverse conditions such as encountered in military use, as if they were simple regular tent fabric by providing equivalent ruggedness. The present membrane affords a chemical and biotoxin protection may times greater than with butyl rubber.

CHEMICAL WARFARE PROOF TENT SHOT FABRIC

CROSS-REFERENCE DATA

This patent application claims priority of co-pending United States patent application No 60/242,820 filed October 24, 2000.

FIELD OF THE INVENTION

This invention relates to protective equipment for soldiers involved in chemical or biological warfare.

BACKGROUND OF THE INVENTION

Since at least the First World War fought between 1914 and 1918, toxic airborne chemical agents have been used by soldiers on one side to disable or kill enemy soldiers on the other side. Examples of such toxic and/or lethal chemical agents include mustard gas - either in the form of "liquid" mustard (HD) or of thickened mustard/glycerine mix -, nerve gaz such as soma (GD), tabun, sarin, VX and lewisite. Toxic biological air borne agents have also been reportedly used in warfare, for example, anthrax.

One problem associated with the use of airborne toxic agents such as chemical poisons or biological toxins, is that they rely on the wind as their vector of transportation, so that after their release by soldiers from one side, if the wind unexpectedly turns back afterwards, these poisons are carried back to their original source and these soldiers can then become poisoned by their own chemical poisons or biological toxins. Moreover, such air borne toxic agents can be released anytime during day or night, even when the soldiers are sleeping in their tents.

Moreover, an additional use could be during counter-errorist activities by security officers, in particular in downtown areas of large cities, for example in the

subway or in or around politically, economically or militarily sensitive buildings. There is current concern about chemical attacks against civilian in heavily populated areas, for example in 1995 in the Tokyo subway with Sarin gas.

Among prior art tentage material, moisture vapour permeable (breathable) fabric sheets cannot boast resistance to HD and GD since they are breathable. Tent fabrics cannot provide specific protection against HD and GD. The other chemical resistant material for garments, may protect against industrial chemicals that most well engineered fabric can resist to, but HD and GD are not conventional industrial chemicals.

OBJECT OF THE INVENTION

The gist of the present invention is to improve upon chemical and biological agents resistant existing tentage material.

SUMMARY OF THE INVENTION

A sheet tentage material suitable for military use (war or terrorism), offering chemical resistance and/or biological attack protection against penetration by mustard gas (HD – standard liquid mustard) , by thickened mustard (THD – mustard glycerine mix), and Soma (GD – a nerve agent), for a period of up to 48 hours. This tentage material is comprised of a polyester textile having a film laminated to it, an inner coating on each side and an outer coating on each side. The material is weldable, and can withstand highly adverse conditions such as encountered in military use, as if they were simple regular tent fabric by providing equivalent ruggedness. The present membrane affords a protection against HD and GD 50 times greater than butyl rubber.

In the present invention, the fabric is a plastisol coated polyester, used not only for tents but also for hangar, aircraft shelters, and many other mobile structures. The present fabric is weldable, i.e. can be constructed without

sewing perforations therethrough, to fully protect against chemical or biotoxin agents ingress. The present fabric could also have infrared reflectance and low gloss.

The invention therefore relates to a plastisol compound for use in coating a fabric membrane suitable as a tentage sheet material for military use, said plastisol compound offering resistance against through penetration by chemical and bio-chemical agents, said plastisol compound including ingredients selected from: - a polymer resin; - a flame retardant; - a plasticizer; and - a biocide; all in sufficient relative proportions to one another such that said plastisol compound is effective for its stated purpose.

The percentage in weight of said polymer resin in said compound could range between 21 and 59 %; that of said flame retardant in said compound, between 5 and 25 %; that of said plasticizer, between 10 and 35 %; and that of said biocide, between 0,1 and 0,5 %.

There could also be added: a pigment, selected from metal based and organic based pigments and having a percentage in weight in said compound being smaller than or equal to 20 %; and/or an adhesion promoter, the percentage in weight of said adhesion promoter in said compound being smaller than or equal to 14 %; and/or a filler, the percentage in weight of said filler in said compound being smaller than or equal to 10 %; and /or an Ultra-Violet Stabilizer, the percentage in weight of said stabilizer in said compound being smaller than or equal to 0,5 %.

The polymer resin could be selected from homopolymer PVC resin and copolymer PVC resin, and/or copolymer PVC blend resin, wherein the ranges of relative percentage in weight in said compound thereof would then be as follows: homopolymer PVC resin: between 18 and 45 %; copolymer PVC resin: smaller than or equal to 10 %; and copolymer PVC blend resin: smaller than or equal to 40 %.

In one exemplary embodiment of plastisol compound, the relative percentage in weight in said compound of each of said ingredients could be as follows:

- homopolymer PVC resin: 37 % ; - copolymer PVC resin: 7 % ; - copolymer PVC blend resin: 6 % ; - flame retardant: 15 % ; - plasticizer: 20 % ; - filler: 0 % ; - pigments: 7,8 % ; - ultra-violet stabilizer: 0 % ; - biocide: 0,2 %; - adhesion promoter: 7 %.

In another exemplary embodiment of plastisol compound, the relative percentage in weight in said compound of each of said ingredients could be as follows: - homopolymer PVC resin: 22 % ; - copolymer PVC resin: 0 % ; - copolymer PVC blend resin: 17 % ; - flame retardant: 11 % ; - plasticizer: 23 % ; - filler: 0 % ; - pigments: 16 % ; - ultra-violet stabilizer: 0 % ; - biocide: 0,2 %; - adhesion promoter: 11 %.

In still another exemplary embodiment of plastisol compound, the relative percentage in weight in said compound of each of said ingredients could be as follows: - homopolymer PVC resin: 30 % ; - copolymer PVC resin: 0 % ; - copolymer PVC blend resin: 20 % ; - flame retardant: 20 % ; - plasticizer: 20 % ; - filler: 0 % ; - pigments: 9,5 % ; - ultra-violet stabilizer: 0,3 % ; - biocide: 0,2 %; - adhesion promoter: 0 %.

In still another exemplary embodiment of plastisol compound, the relative percentage in weight in said compound of each of said ingredients is as follows: - homopolymer PVC resin: 30 % ; - copolymer PVC resin: 4 % ; - copolymer PVC blend resin: 5 % ; - flame retardant: 15 % ; - plasticizer: 29.8 % ; - filler: 3 % ; - pigments: 2 % ; - ultra-violet stabilizer: 0 % ; - biocide: 0,2 %; - adhesion promoter: 11 %.

This invention also relates to a tentage sheet material suitable for military use in screening chemical and bio-chemical agents, said tentage material consisting of a fabric membrane with a plastisol compound coating, said plastisol compound including ingredients selected from: - a polymer resin;

- a flame retardant; - a plasticizer; and - a biocide; all in sufficient relative proportions to one another such that said plastisol compound is effective for its stated purpose.

This invention also further relates to a multi-layer tentage sheet material suitable for military use in screening chemical and bio-chemical agents, said multi-layer tentage material consisting of: - a core fabric membrane made up of a synthetic material and of a barrier polymer layer, said core fabric membrane defining opposite external and internal faces; - a first inner layer of plastisol anchor coat, applied against said external face of said core fabric membrane; - a first outer layer of plastisol top coat, applied against said first inner layer and opening to a free external face of said tentage material; - a second inner layer of plastisol anchor coat, applied against said internal faces of said core fabric membrane; and - a second outer layer of plastisol top coat, applied against said second inner layer and opening to a free internal face of said tentage material opposite said external face of said tentage material; wherein each of said first and second outer layer and each of said first and second inner layer of plastisol include ingredients selected from: - a polymer resin; - a flame retardant; - a plasticizer; and - a biocide; all in sufficient relative proportions to one another such that said plastisol compound is effective in screening chemical and bio-chemical agents.

In this latter embodiment, said barrier polymer layer could be a mono-axially oriented coextruded EVOH (ethyl vinyl acetate) film. This ethyl vinyl acetate film, or equivalent film such as for example polyvinyl acetate and polytetrafluoroethylene, could be of a thickness of for example between 2 and 5 micrometers.

Also, said core fabric material could include: - a first layer of nylon "6" membrane, applied against a face of said EVOH film; - a second layer of nylon "6" membrane, applied against another face of said EVOH film opposite said a face thereof; and - a polyester fabric layer, applied against said second layer of nylon "6" membrane.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION

The present invention consists of applying a membrane on the textile substrate – be it woven or non woven – and subsequently adding the plastisol (for example, powder of polyvinyl chloride) layers on both side. After an exposure to HD or GD, the decontamination process could be more expensive than a new tent. Other than this, the useful lifetime of the present tent fabric would be up to about 7 years.

The tent fabric may consist of eight layers:

a) a plastisol layer top coat
b) a plastisol layer anchor coat
c) a layer of nylon "6" membrane
d) a barrier polymer layer , being preferably a mono-axially oriented coextruded EVOH film
e) a second layer of nylon "6" membrane
f) a textile layer, preferably polyester or Nomex (a non flammable product manufacture under the trademark by Dupont inc.)
g) a plastisol layer anchor coat
h) a plastisol layer top coat (back)

Each of the four above-noted plastisol layers may include the following five ingredients:

1. a resin of PolyVinyl Chloride;
2. a plasticizer mix, preferably including phosphate disodecyle diphenyl and/or dioctylphtalate;
3. a stabilizer, preferably lead phosphate;
4. a flame retardant, preferably chlorinated parafin and/or antimony oxide.
5. a biocide, for example, sodium hypochlorite or a product called Ultrafresh DM-50 (a trademark from Thomson Research and Associates);

Moreover, the two plastisol anchor coat layers should further each comprise a bonding agent, for example, isocyanate or an isocyanate derivative.

It is noted that the two layers of nylon "6" membranes could be co-extruded with the barrier polymer layer. Each of these nylon layers could be for example at least 8 micrometers, and preferably equal to or less than 13 micrometers, thick, without the relative thickness affecting the toxic chemical filtering capabilities, but with the flexibility and thus ease of handling of the textile sheeting being reduced with increased thickness of these nylon membranes. But even at thickness levels greater than 13 micrometers, these nylon membranes would remain effective for their stated purpose.

In the plastisol compound:

- the flame retardants could be a mixture of antimony oxide and/or chlorinated parafin, or a mixture of aluminum trihydrate and/or antimony oxide.
- the plasticizer could be a zinc borate plasticizer, phosphate disodecyle diphenyl, or generally speaking any type of halogenated based plasticizer, including a blend of bromine base, phosphate based, dioctylphtalate and/or dioctyl adipate plasticizers.
- the Ultra-Violet stabilizer could be for example a methyl phenyl benzotriazole, or lead phosphate;
- the pigment could be a metal based pigment, such as iron oxide. If infra-red (IR) reflectance is required, titanium oxide and cadmium derivate could be selected. If no IR reflectance is required, then any organic based pigment can be used.
- the filler: any siliceous and/or calcium based filler could be used;
- the adhesion promoter (i.e. the bonding agent): for example, an isocyanate derivative.
- the biocide: could be e.g. the ultrafresh DM-50 manufactured by .....

With respect to the multilayer membrane, the following materials could for example be used: ethyl vinyl acetate; polyvinyl acetate, or polytetrafluoroethylene. A preferred thickness would be between 2 and 5 micrometers for this membrane, being sandwiched between two layers of nylon each having a thickness ranging between 80 and 127 micrometers.

With respect to the fabric substrate, a decitex polyester fabric is preferred, although other suitable materials could be used, for example, polyamide. Satisfactory performance was achievd with a yarn size of 500 decitex, but it is to be understood that the denier yarn size does not by itself impact on the bio-chemical toxic screening performance of the tentage material; accordingly, any woven or non woven fabric ranging for example between 150 to 1200 decitex yarn size could be used effectively in this product.

The overall weight of the tentage could be for example between 450 and 540 grams per square meter, if the 500 decitex yarn size fabric is retained. Other yarn size could result for example in weights ranging from 300 to 800 grams per square meter.

The efficiency of the present tent fabric has been tested, with each of the four examples of plastisol composition and with the multilayer tentage arrangement described hereinabove. Results of theses tests have revealed that the residual molecule count left in a particle measuring device, after 24 hours of HD and GD application and at 30 C temperature and 0.5 meter per second wind condition, was 0.21 micrograms for mustard gas and 0.47 micrograms for the nerve agent. Even after only two hours, this cumulative agent vapour penetration was approximately 0.02 for HD and approximately 0.09 micrograms for GD.

The present tentage sheet material is destined to resist against most of the toxic chemicals identified in Schedule 1 of the Chemical Weapons Convention, as opened for signature in Paris, France on 13 January 1993 and as entered into force on 29 April 1997. By toxic materials, it is meant any chemical which through its chemical action on life processes, can cause death, temporary incapacitation or permanent harm to humans or animals. However, riot control agents would not be excluded from this list, being any chemical which can produce rapidly in humans sensory irritation or disabling physical effects, which disappear within a short time following termination of exposure. Examples of such toxic chemical materials from Schedule 1 of the Chemical Weapons convention include:

- Sarin, (O-Isopropyl methylphosphonofluoridate), or Soman (O-Pinacolyl methylphosphonofluoridate), as well as any O-alkyl (including cycloalkyl) alkyl (Me, Et, n-Pr or i Pr)-phosphonofluoridates;
- Tabun (O-Ethyl N, N-dimethyl phosphoramidocyanidate), as well as any O-alkyl (including cycloalkyl) N, N-dialkyl (Me, Et, n-Pr or i-Pr) phosphoramidocyanidates;
- VX (O-Ethyl S-2-diisopropylaminoethyl methyl phosphonothiolate), as well as any O-Alkyl (including cycloalkyl) S-2-dialkyl (Me, Et, n-Pr or i-Pr) - aminoethyl alkyl (Me, Et, n-Pr or i-Pr) phosphonothiolates and corresponding alkylated or protonated salts;
- sulfur mustards (2-chloroethylchloromethylsulfide);
- mustard gas (Bis(2-chloroethyl)sulfide or Bis(2-chloroethylthio)methane);
- Sesquimustard (1,2-Bis(2-chloroethylthio)ethane
- 1,4-Bis(2-chloroethylthio)-n-butane ;
- 1,3-Bis(2-chloroethylthio)-n-propane;
- 1,5-Bis(2-chloroethylthio)-n-pentane;
- Bis(2-chloroethylthio)ether;
- O-mustard (Bis(2-chloroethylthioethyl)ether;
- lewisites (chlorovinyldichloroarsine, Bis(2-chlorovinyl)chloroarsine, or Tris(2-chlorovinyl)arsine;
- nitrogen mustards , namely, HN1 (Bis(2-chloroethyl)ethylamine), HN2 (Bis(2-chloroethyl)methylamine), and HN3 (Tris(2-chloroethyl)amine).
- Saxitoxin; and
- ricin.

The present tentage material will be fully effective against any type of above-mentioned toxic chemical or biotoxin agent, in fluid state including in gaseous state and in liquid state.

Although reference was made to sheet material for tents, it is to be understood that other applications are within the scope of the present invention, for example, any type of sheet sheltering.

I CLAIM :

1. A plastisol compound for use in coating a fabric membrane suitable as a tentage sheet material for military use, such that the fabric membrane offers resistance against through penetration by chemical and bio-toxic agents, said plastisol compound including ingredients selected from:

- a polymer resin;
- a flame retardant;
- a plasticizer; and
- a biocide;

all in sufficient relative proportions to one another such that said plastisol compound is effective for its stated purpose.

2. A plastisol compound as in claim 1,
wherein the percentage in weight of said polymer resin in said compound ranges between 21 and 59 %.

3. A plastisol compound as in claim 1,
wherein the percentage in weight of said flame retardant in said compound ranges between 5 and 25 %.

4. A plastisol compound as in claim 1,
wherein the percentage in weight of said plasticizer in said compound ranges between 10 and 35.

5. A plastisol compound as in claim 1,
wherein the percentage in weight of said biocide in said compound ranges between 0,1 and 0,5 %.

6. A plastisol compound as in claim 1,
wherein the ranges of relative percentage in weight in said compound of each of said ingredients are as follows:

said polymer resin, between 21 and 59 %;
said flame retardant, between 5 and 25 %;
said plasticizer, between 10 and 35 %; and
said biocide, between 0,1 and 0,5 %.

7. A plastisol compound as in claim 6,
wherein said compound further includes a pigment, selected from metal based and organic based pigments, said pigment having the percentage in weight of said pigment in said compound being smaller than or equal to 20 %.

8. A plastisol compound as in claim 7,
wherein said compound further includes an adhesion promoter, the percentage in weight of said adhesion promoter in said compound being smaller than or equal to 14 %.

9. A plastisol compound as in claim 8,
wherein said compound further includes a filler, the percentage in weight of said filler in said compound being smaller than or equal to 10 %.

10. A plastisol compound as in claim 9,
wherein said compound further includes a Ultra-Violet Stabilizer, the percentage in weight of said stabilizer in said compound being smaller than or equal to 0,5 %.

11. A plastisol compound as in claim 1,
wherein said polymer resin is selected from homopolymer PVC resin and copolymer PVC resin.

12. A plastisol compound as in claim 10,
wherein said polymer resin is selected from homopolymer PVC resin, copolymer PVC resin and copolymer PVC blend resin, and wherein the ranges of relative percentage in weight in said compound thereof are as follows:
homopolymer PVC resin: between 18 and 45 %;

copolymer PVC resin: smaller than or equal to 10 %;
copolymer PVC blend resin: smaller than or equal to 40 %.

13. A tentage sheet material suitable for military use in screening chemical and bio-chemical agents, said tentage material consisting of a fabric membrane with a plastisol compound coating, said plastisol compound including ingredients selected from:

- a polymer resin;
- a flame retardant;
- a plasticizer; and
- a biocide;

all in sufficient relative proportions to one another such that said plastisol compound is effective for its stated purpose.

14. A multi-layer tentage sheet material suitable for military use in screening chemical and bio-chemical agents, said multi-layer tentage material consisting of:

- a core fabric membrane made up of a synthetic material and of a barrier polymer layer, said core fabric membrane defining opposite external and internal faces;
- a first inner layer of plastisol anchor coat, applied against said external face of said core fabric membrane;
- a first outer layer of plastisol top coat, applied against said first inner layer and opening to a free external face of said tentage material;
- a second inner layer of plastisol anchor coat, applied against said internal faces of said core fabric membrane; and
- a second outer layer of plastisol top coat, applied against said second inner layer and opening to a free internal face of said tentage material opposite said external face of said tentage material;

wherein each of said first and second outer layer and each of said first and second inner layer of plastisol include ingredients selected from:

- a polymer resin;
- a flame retardant;
- a plasticizer; and

- a biocide;

all in sufficient relative proportions to one another such that said plastisol compound is effective in screening chemical and bio-chemical agents.

15. A tentage material as in claim 14,

wherein said barrier polymer layer is selected from ethylvinyl acetate, polyvinyl acetate and polytetrafluoroethylene.

16. A tentage material as in claim 15,

wherein said core fabric material includes:

- a first layer of nylon membrane, applied against a face of said polymer layer;
- a second layer of nylon membrane, applied against another face of said polymer layer opposite said a face thereof; and
- a polyester fabric layer, applied against said second layer of nylon membrane.

17. A tentage material as in claim 16,

wherein each of said first layer and second layer of nylon membrane is at least about 8 micrometers thick, while said polymer layer is at least about 2 micrometers thick.

18. A tentage material as in claim 17,

wherein each of said first layer and second layer of nylon membrane is at most about 13 micrometers thick, while said polymer layer is at most about 5 micrometers thick.